

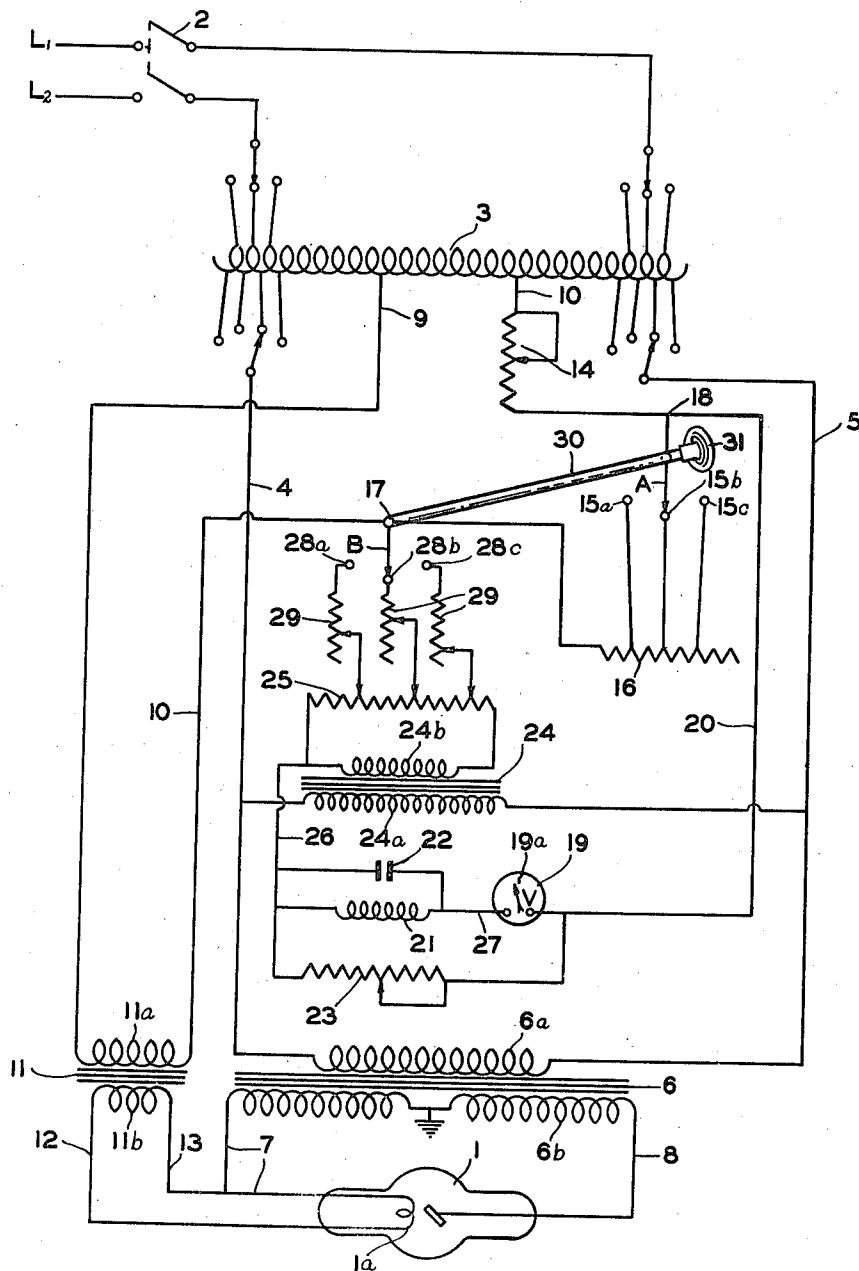
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METER SYSTEM FOR X-RAY TUBES

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METER SYSTEM FOR X-RAY TUBES

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This invention relates to improvements in means for metering the current supplied to the filament of an X-ray tube and to means for quickly adjusting tube supply circuits for a predetermined tube output.

One of the objects of the present invention is to provide means for changing the indication of current supplied to the tube filament to compensate for changes in the saturation of the X-ray tube at various kilovoltages so that more or less filament current will be supplied to give a predetermined tube output, taking into account the change in tube output upon a change in the impressed kilovoltage.

Another object of the present invention is to provide a plurality of selective resistances in the filament transformer primary with a corresponding set of respectively proportionate resistances in the meter circuit, together with means for coincidentally selecting two proportionate resistances whereby the meter circuit will accurately read the current supplied to the filament transformer primary no matter which resistance is selected.

Another object of the present invention is to combine in a single tube control system the two above mentioned features, namely, the automatic compensation for changes in high tension voltage and the compensation for changes in resistance in the filament transformer primary circuit, together with adjustable means for varying the current in the filament transformer primary whereby the system may be set for a desired tube output, after which a quick adjustment of said adjustable means will bring a voltmeter indicator to a predetermined point, thus automatically setting the tube for the desired output.

Other novel features and advantages of my improved tube control apparatus will be apparent from the specification and the accompanying drawing and the essential features thereof will be set forth in the claims.

The drawing shows a diagram illustrating one embodiment of my invention. A standard X-ray tube 1 has a filament 1a. Power is supplied to the tube from the source L₁, L₂ through switch 2 and autotransformer 3 having leads 4 and 5 connecting it with the primary 6a of the transformer 6 whose secondary 6b is connected by leads 7 and 8 with the anode and cathode of the tube 1. This is a simple circuit using only half wave rectification but it will be understood by those skilled in the art that this is for illustrative purposes only and that my device is applicable to any type of circuit.

Current may be supplied to the tube filament 1a in any suitable manner, that shown herein comprising leads 9 and 10 tapped into the autotransformer and supplying the primary 11a of the filament transformer 11 whose secondary 11b is connected to the filament 1a by the leads 12 and 13. Means is provided for controlling the current supplied to the filament transformer primary 11a as indicated at 14. The means here shown is an adjustable resistance but it will be understood that an adjustable inductance or other control means is within the scope of my invention.

Connected in series in the lead 10 of the filament transformer primary circuit is a selector switch A having a plurality of taps 15a, 15b, 15c of which there may be any number desired but for convenience three only are shown. Each tap is connected at a different point along the resistor 16 so as to provide progressively increasing resistance in the filament transformer primary circuit as the switch A is moved from tap 15a to 15b or to 15c.

A metering circuit is connected between the points 17 and 18 in a shunt connection around the selective resistances 16. A voltmeter 19 has one of its binding posts connected by lead 20 to the point 18 and has its other binding post connected through various devices to the point 17. Thus the meter 19 will indicate the current flowing in the filament transformer primary circuit. Preferably but not necessarily this voltmeter will be of the type having a single indication as at 19a so that it is a very simple matter in adjusting the apparatus to bring the needle of the voltmeter to the single point to indicate a proper setting of the apparatus.

Provided in series with the meter 19 is an inductor 21 which may or may not be provided with a core and the purpose of which is to render the meter 19 more sensitive, that is to say, to cause a slight change in voltage passing through the inductor to produce a wide variation in the current passing through it. The capacitor 22 is connected in parallel with the inductor to make possible a more uniform and accurate series of readings over the range of the device. The adjustable resistance 23 is supplied in parallel with the inductor and the capacitor and the meter 19 to select the proper operating conditions and to compensate for slight variations occurring in manufacture. This portion of the meter circuit involving the members 21, 22 and 23 is more fully disclosed, described and claimed in the Patent to Caperton B. Horsley, granted September 12, 1939,

No. 2,172,581, to which reference may be had for a more complete explanation thereof.

It is well understood that tube output is most readily controlled by varying the filament current. It is also well understood, however, that tube output varies with the changes in saturation of the X-ray tube, that is to say, if the kilovoltage across the tube is raised, other factors remaining the same, the milliamperage of the tube output will increase. This represents an increase of between fifteen and twenty per cent within the limits of operation of the tube. The present invention provides means for indicating in the metering circuit just described this change in tube output due to change in the high tension current supplied to the tube. For this purpose I provide a compensating transformer 24 whose primary 24a is connected between leads 4 and 5 so that it receives the same voltage as that supplied to the primary 6a of the high tension transformer. The secondary 24b is connected to the resistor 25 which is a part of the metering circuit connected with voltmeter 19 by lines 26 and 27 through the inductor 21. Between point 17 and the resistor 25 I provide a selector switch B having a plurality of taps 28a, 28b and 28c, each tap being connected through an adjustable resistance 29 to an appropriate point on resistor 25. Means is provided for coincidentally operating switches A and B so as to simultaneously select taps 15a and 28a or 15b and 28b, etc., so that when one of the resistances 16 is selected an appropriate resistance 25 is at the same time connected in the metering circuit. The means here shown comprises a common shaft 30 for operating switches A and B, there being an operating knob 31 suitably located on the instrument panel. By properly selecting the taps on resistor 25 and adjusting the adjustable resistances 29, the resistance connected in the meter circuit upon selection of any tap by switch B is proportionate to the corresponding resistance selected by the switch A so that the metering circuit is compensated for changes in the selected resistances 16. If desired the switch A and its taps may be calibrated in terms of tube output. Then in operating the device the operator first selects at the autotransformer the desired kilovoltage and adjusts switch A to the desired tube output. The same adjustment moves switch B to provide the suitable compensating resistance in the metering circuit and transformer 24 applies a correcting voltage to resistor 25 to change the indication on voltmeter 19 to compensate for changes in tube output due to changes in the high tension voltage supplied to transformer 6. The needle of voltmeter 19 should then be very close to the indication 19a and may be quickly brought to that point by adjusting the variable resistance 14. This will compensate for any variations in the supply to autotransformer 3 or for changes in resistance anywhere in the filament circuit.

The association of transformer 24 with resistor 25 is such as to impress a voltage on meter 19 which increases and decreases as the kilovoltage in primary 6a increases and decreases respectively. The value of this compensating voltage in the metering circuit is so selected as to produce a constant voltage at meter 19 for a given tube output and which is the total result of the change in tube output as the result of changes in tube saturation plus the current supplied in the filament transformer primary. For instance, for a variation in total kilovolts across the leads 1, 8 from 40 to 80, there would normally be a change

in tube milliamperage of 200 to 230 with the same filament voltage and current.

What I claim is:

1. X-ray apparatus, comprising a tube, a supply of high tension current therefor, said tube having a filament and a current supply for said filament, means for varying said filament current, meter means for measuring a characteristic of the current supplied to said filament including a metering circuit, and variable means in said metering circuit responsive to said tube supply current and operable by said filament-current-varying-means to produce variable effects in the meter circuit and thereby produce compensation in said meter means to correspond with the changes in tube output.

2. X-ray apparatus, comprising a tube, having a supply of high tension current therefor, said tube having a filament and a current supply for said filament, means for varying said filament current including a variable resistance in said filament supply circuit, a metering circuit having a shunt connection around said resistance, a meter in said circuit for measuring electrical flow therein, variable resistance in said metering circuit, and operating means coupling said two resistances for varying said last named resistance by variation of said first named resistance in amounts to compensate in said metering circuit for the changes in said filament circuit.

3. X-ray apparatus, comprising a tube, a supply of high tension current therefor, said tube having a filament and a current supply for said filament, means for varying said filament current including selective resistances of progressively increasing amounts in said filament supply circuit, a metering circuit having a shunt connection around said resistances, a meter in said circuit for measuring electrical flow therein, resistances in said metering circuit of progressively increasing amounts, said last named resistances having proportionate values respectively to said first named resistances, and means for simultaneously selecting corresponding proportionate resistances in the two circuits.

4. X-ray apparatus, comprising a tube, a high tension transformer having said tube connected in its secondary circuit, means for varying the voltage in said secondary circuit, said tube having a filament, a filament transformer having said filament connected in its secondary circuit, adjustable means for varying the current flow in said filament transformer primary, selective resistances in the primary circuit of said filament transformer, a metering circuit having a shunt connection around said resistances, a voltmeter in said circuit having a single indication, means for impressing a voltage on a portion of said metering circuit, said last named means including a compensating transformer whose primary is subject to the current of said high tension transformer primary, a plurality of resistances adapted to be selectively placed in electrical connection with said metering circuit, said last named resistances having values each respectively proportionate to one of said first named resistances, and means for coincidentally selecting one of said first named resistances and its proportionate second named resistance, whereby with any selected high tension voltage the voltmeter may be brought quickly to its single indication by said adjustable means, whereupon the tube output will have predetermined value.